

## Claims

What is claimed is:

- 1        1. A method for forming a quadruple density sidewall image transfer (SIT) structure comprising the steps of:
  - 3                forming oxide spacers on opposite sidewalls of a first mandrel; said oxide spacers forming a second mandrel;
  - 5                forming sidewall spacers on opposite sidewalls of said oxide spacer second mandrel; and
  - 7                using a pattern of said sidewall spacers to form the quadruple density sidewall image transfer (SIT) structure.
- 1        2. A method as recited in claim 1 wherein the step of forming oxide spacers on opposite sidewalls of said first mandrel includes the steps of providing a starting structure including multiple layers; said multiple layers including a substrate, a gate dielectric layer, and a gate conductor.
- 1        3. A method as recited in claim 2 wherein said multiple layers of said starting structure further include an oxide hardmask layer, a poly etch stop layer, a first nitride layer, and a poly mandrel layer capped with a second, thinner nitride layer.
- 1        4. A method as recited in claim 3 wherein the step of forming oxide spacers on opposite sidewalls of said first mandrel further includes the steps of providing a print mandrel mask on said starting structure; using said print mandrel mask and etching said second, thinner nitride layer and said poly mandrel layer to define said first mandrel; and removing said print mandrel mask.
- 1        5. A method as recited in claim 4 wherein the step of forming said oxide spacers on opposite sidewalls of said first mandrel further includes the steps of thermally growing oxide hardmask spacers on opposite sidewalls of said first mandrel.

1        6.    A method as recited in claim 5 further includes the step of  
2 filling any undercut profile of said thermally grown oxide hardmask spacers  
3 on opposite sidewalls of said first mandrel using a thin Chemical Vapor  
4 Deposition (CVD) oxide.

1        7.    A method as recited in claim 5 further includes the step of  
2 removing said first mandrel.

1        8.    A method as recited in claim 4 wherein the step of forming  
2 sidewall spacers on opposite sidewalls of said oxide spacer second mandrel  
3 includes the steps of forming nitride hardmask spacers on opposite  
4 sidewalls of said oxide spacer second mandrel.

1        9.    A method as recited in claim 8 includes the steps of forming  
2 said nitride hardmask spacers by conformal deposition and directional etch  
3 of a nitride layer on opposite sidewalls of said oxide spacer second mandrel.

1        10.   A method as recited in claim 8 includes the steps of removing  
2 said oxide spacer second mandrel; and removing said first nitride layer, said  
3 poly etch stop layer, and said oxide hardmask layer by Reactive Ion Etching  
4 (RIE), while maintaining a profile and a width of said nitride hardmask  
5 spacers.

1        11.   A method as recited in claim 8 wherein the step of using said  
2 pattern of said sidewall spacers to form the quadruple density sidewall  
3 image transfer (SIT) structure includes the steps of transferring said pattern  
4 of said nitride hardmask spacers into said poly etch stop layer, and said  
5 oxide hardmask layer to form the quadruple density sidewall image transfer  
6 (SIT) structure.